100195

Environmental Standards, Inc.

Specialists in Environmental Risk Assessment and Data Validation

The Commons at Valley Forge, Unit 4, 1220 Valley Forge Rd.
P.O. Box 911, Valley Forge, PA 19481 (215) 935-5577

November 18, 1988

Diane Wehner
Department of Natural Resources
and Environmental Control
Division of Air and Waste Management
CERCLA Management Branch
715 Grantham Lane
New Castle, DE 19720

Re: Preliminary Toxicological Evaluation of the Standard Chlorine of Delaware Site.

Dear Ms. Wehner:

I have reviewed the reports prepared by Weston entitled: "Documentation Report: Groundwater Recovery Operations" and "Report on Response and Cleanup Efforts of a 5 January 1986 Chlorobenzene Spill." Enclosed are two (2) copies of a report which is intended to: 1) identify informational elements that would be required to properly perform an in-depth analysis of hazards posed to human health and the environment, 2) provide brief background information on the toxicology and regulatory status of relevant chlorinated benzenes, and 3) present quantitative estimations of risk where feasible, based on the available limited data.

It is important to note that the weight of evidence for the carcinogenic status of monochlorobenzene and para-dichlorobenzene (pDCB) is currently under re-evaluation. At issue with regard to pDCB is whether there exists "sufficient" evidence of carcinogenicity or whether there is "limited" evidence of carcinogenicity. The reason this may be important is that the final MCL of 0.075 mg/L promulgated for pDCB was based on a Regulatory Category II classification and may soon be revised (to a lower level) if the current classification as a probable human carcinogen (Group B2) is retained. (The cancer risk from drinking 2 liters per day of water containing pDCB at the current MCL is estimated to be 5×10^{-5}).

It is also important to emphasize that, in addition to toxicity aesthetic characteristics of water quality can l
determining whether water is suitable for dri
Chlorinated benzenes can impart a pungent taste an... ...to water

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at extremely low concentrations. For example, monochlorobenzene has a taste and odor threshold at 0.00041 to 0.0015 mg/L, and comparable thresholds have been determined for pDCB.

I trust the enclosed report will prove helpful in your efforts to resolve the problems resulting from the major spills of chlorinated benzenes at this Delaware site. If you have any questions, or if I can be of any further assistance, please give me a call.

Sincerely yours,

Kenneth G. Symms

Kenneth G. Symms, Ph.D.
Toxicologist/Principal

ENVIRONMENTAL STANDARDS, INC.

KGS:cs
Enc.

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State of Delaware
DNREC, DAWM
CERCLA Management Branch
715 Grantham Lane
New Castle, DE 19720

Invoice No. 8811-1120
Invoice Date 11/30/88
Job Number 8808050
Terms ON RECEIPT
Fed. ID No. 23-2484428

Attention: Diane E. Wehner

Purchase Order 40- 289262

INVOICE

DESCRIPTION	HOURS	RATE	AMOUNT
For Professional Services Rendered- Public Health and Environmental Risk Assessment for the Standard Chlorine Superfund Site.			
Kenneth G. Symms, Ph.D.			
Review of Weston reports: teleconference to obtain further details.	3.5	$85.00	$ 297.50
Research on carcinogenic status of chlorinated benzenes (data-base searches, teleconferences with various EPA offices); other health effects of chlorinated benzenes.	4.75	85.00	403.75
Research on area hydrogeology and principles to determine vulnerability from free product spills.	5.5	85.00	467.50
Preparation of report with full bibliographic documentation.	30.5	85.00	2,592.50
Word Processing, Editing	5.5	30.00	165.00
Technical research support: data base searches: reference compilation.	8.0	35.00	280.00
Federal Express			14.50
On-line data base charges			22.35
Communication Charge			85.00
			$ 4,328.60

Received 11-19-88 DEW

two slip sheets including

The itemization presented above represents the actual labor and costs of performing the above named risk assessment. Please note that this exceeds an estimate of $2,500 given as an average in a proposal for a generic risk assessment. As noted in the original proposal dated July 5, 1988, a risk assessment can generally be accomplished in 45 hours or less, depending on the complexity of the site and the availability of adequate data. Should the difference between actual cost and the amount indicated in th create a problem, please contact Dr. Kenneth G. Symms a Standards, Inc.

AR300024

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF AIR & WASTE MANAGEMENT
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

WASTE MANAGEMENT
SECTION

TELEPHONE: (302) 736 - 4781

MEMORANDUM

TO: Phillip G. Retallick

THRU: Gary A. Molchan 8/2/88 for Joseph Hardman
Joseph J. Hardman
Galina B. Chadwick GBC 8/2/88

FROM: Diane E. Wehner DEW 8-2-88

RE: Public Health and Environmental Risk Assessment for the Standard Chlorine Superfund Site

DATE: August 2, 1988

I would like to have a public health and environmental risk assessment of the Standard Chlorine of Delaware facility performed. This information would be essential to the successful management of remediation of the site. Monies for such activities are readily available through the Multi-site Cooperative Agreement we have entered into with EPA.

I have contacted several local firms by phone to obtain bids for the completion of the assessment. The following is a listing of their names and prospective estimates:

Environmental Resources Management (ERM), Inc.	$ 5,000 - $10,000
Environmental Standards, Inc. (ESI)	$ 1,000 - $ 3,800
Tetra Tech, Inc.	$ 5,000 - $ 6,000
Versar, Inc.	$ 8,000 - $15,000

Based on the information presented above, I would like to retain the services of Environmental Standards, Inc. (ESI) (see purchase order #289262 attached). Not only is ESI's bid the lowest but their qualifications to perform the work are outstanding (see credentials attached).

Please sign the attached proposal to indicate concurrence with this selection

and return to me for processing. If you desire further clarification on this issue, please contact me as soon as possible as I would like to have the work completed prior to Standard Chlorine's initiation of their Remedial Investigation/Feasibility Study (RI/FS) activities.

DEW:dls
DEW2151

Attachments

Environmental Standards, Inc.
Specialists in Environmental Risk Assessment and Data Validation

The Commons at Valley Forge, Unit 4, 1220 Valley Forge Rd.
P.O. Box 911, Valley Forge, PA 19481 (215) 935-5577

A PRELIMINARY RISK ASSESSMENT OF THE STANDARD CHLORINE OF DELAWARE, INC. SITE IN DELAWARE CITY

Prepared for:

STATE OF DELAWARE

Department of Natural Resources and Environmental Control
Division of Air and Waste Management
CERCLA Management Branch
715 Grantham Lane
New Castle, Delaware 19720

Prepared by:

Kenneth G. Symms, Ph.D., Toxicologist

ENVIRONMENTAL STANDARDS, INC.

The Commons at Valley Forge
1220 Valley Forge Road, Unit 4
P.O. Box 911
Valley Forge, Pennsylvania 19481

1.0 INTRODUCTION

A spill of 400,000 gallons of p-dichlorobenzene ($_p$DCB) and 169,000 gallons of trichlorobenzene (TCB) at the Standard Chlorine of Delaware, Inc. facility in January of 1986, resulted in a flow of free product into a tidally influenced tributary to Red Lion Creek and adjacent wetlands. In response, Weston Services, Inc. was contracted by Standard Chlorine of Delaware to delineate the extent and magnitude of the release and to cleanup gross chlorinated benzene contamination in the affected surface waters and wetlands in the vicinity. In addition, Weston has instituted a groundwater pumping and contaminant recovery program in response to an unrelated past spill of 5000 gallons of monochlorobenzene on the Standard Chlorine property. Information regarding these separate contamination events is provided in two reports prepared by Weston and its subsidiary, Weston Services, Inc., entitled:

1) "Documentation Report: Groundwater Recovery Operations," April 22, 1988.

2) "Report on Response and Cleanup Efforts of a 5 January 1986 Chlorobenzene Spill," April 22, 1988.

Some indication of the Current levels and extent of contamination of on-site groundwater and off-site surface waters and sediments is presented in these reports. However, in order to properly ascertain potential impacts on public health, welfare, and the environment, additional data may be required. The purpose of this assessment is to identify data gaps (i.e., information that may be essential to an in depth risk assessment) and to provide a preliminary

evaluation of the possible adverse impacts due to releases of chlorinated benzenes based on the limited data offered in the Weston reports.

2.0 CONSIDERATIONS FOR IDENTIFYING POTENTIALLY EXPOSED POPULATIONS

Little information is available at this time concerning uses of the impacted wetlands and surface waters, population densities (demographic data), and uses of groundwater in the area. Red Lion Creek is apparently utilized recreationally and is sport-fished. It is noted in the Weston report that the Delaware Department of Public Health issued an advisory in May of 1986 recommending that the public not consume fish taken from Red Lion Creek downstream of Route 13 in New Castle County. In addition, whether private domestic wells are located in proximity to warrant consideration is not known. However, the Artesian Water Company utilizes a well field in the vicinity of the site.

Potential exposure routes for human contact to consider include:

- ingestion of contaminated drinking water
- direct contact with contaminated surface soils (incidental ingestion and possibly dermal absorption)
- indirect exposure via consumption of contaminated fish.
- air exposure due to volatilization from the contaminated surfaces.

In addition, environmental impacts should be assessed in a more detailed assessment, considering the involvement of wetlands and a sensitive surface water body. A wetlands investigation should encompass the approach outlined in EPA's recently released document entitled: "Wetland Identification and Delineation Manual, 1988 (Office of Wetland Protection). EPA's Water Quality Criteria document (1986) lists a criterion of 763 ug/L of dichlorobenzene to protect freshwater aquatic life. Acute toxicity to freshwater aquatic life occurs at concentrations as low as 250 ug/L and chronic toxicity at levels below 50 ug/L for total chlorinated benzenes. Concentrations of up to 1666 ug/L were reported (post dredging) in water samples collected from the unnamed tributary to Red Lion Creek. Impacts on freshwater aquatic life are likely.

3.0 CONSIDERATIONS FOR ESTIMATING EXPOSURE POINT CONCENTRATIONS

Any assessment of potential exposure critically depends upon the accuracy of data reflecting concentrations of chemicals in various media to which humans are likely to be exposed.

3.1 Groundwater

The Weston report entitled, "Documentation Report Ground Water Recovery Operations" states that the contamination plume, defined by contouring total benzenes, extends beyond the Standard Chlorine boundaries onto Diamond Shamrock property. Concentrations of total organics (or total benzenes) in recovery wells

ranged from 83,000 ug/L in RW-4 to 276,000 ug/L in RW-2 as of March, 1988. It is assumed that the vast majority of "total organics" is comprised of monochlorobenzene. It is possible that benzene, a known human carcinogen which is very mobile in the geohydrosphere, can be formed by dehalogenation reactions and may be present. Proper characterization of the groundwater should include quantitative analysis of EPA's Target Compound List (TCL) including mass spectral library searches for extraneous chromatographic peaks. In addition, it is highly desirable that the resultant data be subjected to a rigorous quality assurance review (viz., according to EPA's Functional Guidelines for Validating Organic Data, 1988).

The effectiveness of the existing recovery wells to intercept and confine a plume of chlorobenzene is not demonstrated by the data presented in the Weston report. No monitoring well sample results were included in the report. The isoconcentration map provided (see Figure 3 of the Weston Documentation Report) appears to indicate that contamination extends for an unknown distance beyond the intercepting recovery wells. Moreover, all of the pumping wells have been inoperable for significant periods of time (e.g., more than 9 consecutive months out of 22 months of operation for well RW-3.) Thus, the possibility that heavily contaminated groundwater may have migrated beyond the influence of the hydraulic cones of depression created by operational pumping wells cannot be discounted. The installation of additional monitoring wells downgradient of the existing well cluster is needed to obtain the data necessary to characterize the status of the downgradient groundwater and to determine whether the intermittent pumping of recovery wells has, in fact, effectively confined the plume(s). Additionally, no information is provided concerning the lower aquifer. Considering that free product, which is much heavier than water, could have permeate

confining zone (i.e., clay layer) it may be important to ascertain whether contamination has or could infiltrate into and affect the underlying aquifer. Drawdown in the uppermost confined aquifer, created by local production wells, could greatly accelerate contaminant migration through the clay layer. An examination of the isoconcentration map (October 1983 results as indicated in figure 4 of the Weston report) indicates that monochlorobenzene was present in monitoring well TW-5 at 700 mg/L or more. However MCB's limit of solubility in water is 448 mg/L at 20° C (HSDB, 1988). The solubility of MCB in groundwater with a temperature of about 13° C is even less. This indicats that MCB was found in the water at levels above saturation and suggests the presence of free product. No information is offered as to whether or not free product exists in the subsurface. Since the contaminants are heavier than water and not readily soluble, free product could accumulate on the upper surface of the clay layer. The regional slope of Coast Plain sediments is to the east. As a result, free product may flow toward the Diamond Shamrock facility despite groundwater flow to the north. No data is provided in the Weston report on subsurface soil contamination. This information is needed to determine the magnitude of the subsurface pollution and the time required for groundwater rehabilitation.

In the Report on Response and Cleanup Efforts of a 5 January 1986 Chlorobenzene Spill, the only mention of groundwater status relates to the conclusion that discharge of highly contaminated groundwater is the reason for elevated chlorobenzenes present in some surface water samples taken from the unnamed tributary to Red Lion Creek. Considering the magnitude of the release and the widespread area of contamination, a high probability exists for significant groundwater contamination.

Once introduced into the saturated zone, DCB frequently shows little

attenuation (Barber et al., 1988; Bower et al., 1984; Hutchins et al., 1983 and 1984). Barber (1988) demonstrated the long-term persistence of DCB in groundwater where an extensive plume with a minimum age of 20 years (perhaps 50 years of age) had extended more than 3500 meters downgradient from disposal beds.

The available data are insufficient to enable a quantitative or even qualitative estimate of the potential endangerment to public water supply wells in the area. The Artesian Water Company wells may not be at any risk of degradation as a result of the spills of chlorinated benzene compounds at the Standard Chlorine facility. However, a hydrogeologic characterization and evaluation of the liability of the deeper aquifer to contaminant infiltration are required to make such a determination. Potential future use of a contaminated shallow aquifer is also of interest from a risk assessment perspective. For example, EPA frequently requires under RCRA or CERCLA an assessment of potential groundwater contamination at the property boundary of a site. The sampling results reflected by isoconcentration profiles as presented in Figure 3 of the Weston report indicate that the concentration of total benzenes exceeds 300,000 ug/L at a significant portion of the northern property boundary. Assuming that this contamination is comprised entirely of monochlorobenzene, a quantitative estimate of the health hazards posed to users of a hypothetical domestic well installed at the property boundary can be derived.

3.2 Surface Soils and Sediments

Contaminated surface sediments in the wetlands represent potential sources of direct contact for fishermen and other individuals who affected areas recreationally. Data on total chlorobenzenes sediments is

provided in the Weston report. However, in characterizing the extent of contamination, samples were collected by shoveling aside the top six inches of soil and collecting the 6- to 12-inch soil interval. In a post-cleanup survey, soil/sediment samples were collected by digging a pit 6 to 10 inches deep and obtaining a one-inch vertical section of the exposed soil profile. Concentrations of chlorobenzenes in sediments sampled in this way reportedly ranged from 0.87 to 1104 mg/kg.

The adequacy of these results in evaluating possible impacts is limited. Samples collected in such a manner do not provide an accurate indication of the concentrations of DCB and TCB in the top layer of the sediments. It is the top few centimeters of sediment that are likely to be contacted by humans, that are important in terms of benthic organisms, dissolution of contaminants into the water phase, release into the air, etc. Analytical results from sediment samples taken to a depth of up to 25 cm may not be relevant to determining exposure point concentrations. Concentrations of chlorinated benzenes in surface sediments could be more than an order of magnitude greater than indicated by the results presented in the Weston report.

3.3 Other Exposure Point Concentrations

Carp and white perch were harvested from Red Lion Creek in April of 1986 and tissues from these fish species were analyzed for the presence of DCB isomers and tetrachlorobenzene. These data indicate whole-body DCB concentrations of 0.94 to 7.6 mg/kg. Tissue levels under current, post-cleanup conditions would be more relevant. It may be noted that the mean bioconcentration factor (BCF) values of 370 L/kg to 720 L/kg for pDCB have been experimentally determined for rainbow trout (HSDB, 1988). The BCF (the chemical concentratior

by that in water) for 1,2,4-TCB in rainbow trout exposed to 3.2 ng/L was determined to be 1300 ± 320 L/kg (HSDB, 1988).

Data were provided in the Weston report for water samples collected in March 1988, from the intermittent stream. No water samples were taken from Red Lion Creek. This information is needed to assess impacts on aquatic life and consumers of the aquatic life. It may be noted that concentrations of chlorobenzenes were very much higher in sediments from Red Lion Creek (samples 8S through 12S) than in sediments from the intermittent stream and bordering wetlands. Concentrations of chlorobenzenes in surface water samples ranged from 4.5 to 1666 µg/L. It is important to note that these data are expressed in terms of total chlorobenzenes. An examination of the analytical laboratory report revealed that, in addition to DCB and TCB, monochlorobenzene and benzene (235 µg/L), a known human carcinogen, were present in sample 2W.

EPA has promulgated ambient water quality criteria for dichlorobenzenes (U.S. EPA, 1986). For the protection of human health from the toxic properties of dichlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is 0.4 mg/L, and 2.6 mg/L for ingestion of aquatic organisms alone. However, it should be emphasized that pDCB is currently regarded as a probable human carcinogen and no level of exposure is without some degree of cancer risk. Accordingly, hazards from ingesting fish should be based on cancer risk estimates (see below).

4.0 TOXICITY ASSESSMENT OF CHLORINATED BENZENES

4.1 p-Dichlorobenzene (pDCB)

Symptoms of acute inhalation intoxication in humans include headache, nausea, dizziness, eye and nasal irritation, fatigue and transient chromosomal abnormalities in leukocytes (Zapata-Gayon et al., 1982). pDCB vapor is painful to most people at concentrations of 50 ppm (300 mg/m^3) and the discomfort becomes quite severe at 160 ppm (HSDB, 1988). When swallowed, DCB and other chlorinated benzenes cause burning pain in the stomach, nausea, vomiting and diarrhea. Isolated cases of pulmonary granulomatosis and hemolytic anemia have been reported after exposure to pDCB (NAS, 1977). Several instances of skin lesions (e.g., pigmentation and allergic dermatitis) which developed after contact also have been reported (EPA, 1985b). Because DCB produces a burning sensation when in contact with the skin for prolonged periods and is absorbed percutaneously (HSDB, 1988), clothing which contacts the material should be removed immediately. The lowest lethal dose for acute oral exposure to humans is given as 857 mg/kg body weight (RTECS, 1988).

Case reports of humans exposed over the long term to ortho-DCB have suggested reticuloendothelial, hematopoietic, and liver effects. Of the 23 exposure cases found in the literature, 17 involved pathological changes in the blood or liver, including chronic lymphoid leukemia, acute hemolytic anemia, aplastic anemia and bone marrow hyperplasia.

In laboratory animals given pDCB (675 and 800 mg/kg) for 13 weeks, histopathological alterations in the liver were observed. Liver cell necrosis, degeneration and porphyria were found in both mice and rats. Rodents given 1500

mg/kg/day suffered hematopoietic hypoplasia of the bone marrow. A no-observed-adverse-effect level (NOAEL) in rats of 150 mg/kg/day was reported (U.S. EPA, 1985a). EPA's risk reference dose for $_{p}$DCB is 0.107 mg/kg/day and a lifetime health advisory for noncarcinogenic toxicity endpoints is 3.75 mg/L (U.S. EPA, 1985a). The MCL and MCLG are both 0.075 mg/L (U.S. EPA, 1987a).

Carcinogenicity. para-Dichlorobenzene is currently listed in EPA's Public Health Risk Evaluation Databank (as of September, 1988) as a Group B2 carcinogen (probable human carcinogen based on sufficient evidence in animals and inadequate data in humans). However, $_{p}$DCB was recently pulled off IRIS, pending review. In November, 1985, EPA classified $_{p}$DCB in Group D (inadequate data to classify). On April 17, 1986, $_{p}$DCB was classified by EPA as a probable human carcinogen (Group B2) based on results of a recent National Toxicology Program (NTP) bioassay which reported significantly increased incidences of kidney and liver tumors in rats and mice (NTP, 1987). Conclusions from the NTP study were that there was clear evidence of carcinogenicity for the male rats and mice of both sexes. However, on July 8, 1987, EPA's Drinking Water Office promulgated an MCLG for $_{p}$DCB (52 FR25697) on the basis of a re-classification to Group C (possible human carcinogen; limited evidence of carcinogenicity in animals in the absence of human data). Subsequently, the classification was upgraded to Group B2, and the status of $_{p}$DCB is currently under review by the Carcinogen Risk Assessment Verification Enterprise (CRAVE), an Agency-wide work group of toxicologists from EPA and the Office of Research and Development. Although there have been reports of chronic lymphoid leukemia and acute myeloblastic leukemia in humans that may be associated with exposure to $_{p}$DCB (HSDB, 1988), the International Agency for Research on Cancer (IARC) has concluded that the human data are inadequate to evaluate the carcinogenicity of dichlorobenzenes (IARC, 1982).

The carcinogen potency factor (CPF) for pDCB has been established. The upper-limit CPF for oral exposure to humans is 2.4×10^{-2} risk units per mg/kg/day of lifetime exposure (U.S. EPA, 1988a, 1988b).

4.2 Monochlorobenzene (MCB)

Chlorobenzene is irritating to the skin, mucous membranes and eyes, and causes central nervous system (CNS) depression. In humans, acute eye and nasal irritation occur at 200 ppm in air. At this concentration, the odor is pronounced and unpleasant. In one case of accidental poisoning of the liquid by a child, there was pallor, cyanosis, and coma, followed by complete recovery.

Chronic exposure to DCBs may result in blood dyscrasias and lung, liver and kidney damage. The principle target organs of MCB are the CNS, liver, and kidney. Leukopenia and depressed bone marrow activity were found in mice exposed to 544 ppm 7 hrs/day for 3 weeks or at 22 ppm for 3 months (Patty's, 1981). EPA has derived a risk reference dose of 0.09 mg/kg/day (EPA, 1985a) and proposed an MCLG of 0.06 mg/L (U.S. EPA, 1985c). Gastric intubation of 120 mg/kg/day for 2 years produced a slight but statistically significant increase in neoplastic nodules of the liver in male rats (NTP, 1985). On the basis of the draft 1983 NTP report, the National Academy of Sciences has estimated a cancer risk of 10^{-6} (one in one million) at a drinking water concentration of 2.4 ug/L (NAS, 1983; U.S. EPA, 1985c).

4.3 1,2,4-Trichlorobenzene (TCB)

In humans, TCB has produced eye and respiratory irritation. In animals, acute exposures have produced local irritations, convulsions and death; subchronic inhalation and oral exposures have induced enzymes, increased liver

and kidney weights and increased urinary porphyrin excretion. The liver, kidney, adrenal, mucous membranes and brain ganglion cells appear to be target sites with effects including edema, necrosis, fatty infiltration of the liver, etc. (U.S. EPA, 1985b).

A risk reference dose of 0.0003 mg/kg/day has been developed by EPA (EPA, 1987b). TCB is appropriately classified in Group D with regard to its carcinogenic status.

5.0 ESTIMATE OF CHEMICAL INTAKES AND RISK CHARACTERIZATION

5.1 Contaminated Groundwater

On the basis of data provided in the Weston report concerning the recovery of monochlorobenzene (MCB) in groundwater, a clear hazard would be posed to users of a future domestic well located at the property boundary. While this may or may not be a plausible exposure scenario, the concept of a hypothetical well at the site boundary is often times utilized as a benchmark for Corrective Action Plans (CAPs) or Alternative Concentration Limits (ACLs) under RCRA, and a performance goal in Superfund remediations.

Assuming that the concentrations of "total benzenes" are comprised entirely of chlorobenzene (i.e., no benzene or other probable human carcinogens), the concentration of MCB in a hypothetical well is assumed to be 100,000 to 300,000 ug/L (see figure 3 in Weston's "Documentation Report, Ground Water Recovery Operations", April, 1988). It is also assumed that an average concentration of 200,000 ug/L is likely to persist for several years, despite recovery operations

(there is evidence to suggest a reservoir of free product in the subsurface; chlorobenzene is relatively persistent in the geohydrosphere). Assuming the affected water could be tolerated, since chlorobenzene can impart a pungent chemical taste and odor at very lower levels, an ingestion of 2 liters/day would result in an intake of 400 mg/day, or 5.7 mg/kg/day for a 70-kg adult.

The U.S. EPA has derived an acceptable intake for chronic (AIC) oral exposure to chlorobenzene of 3.0×10^{-2} mg/kg/day (U.S. EPA, 1988a; 1988b). A hazard index of 190 is calculated for long-term daily consumption of water containing 200,000 ug/L of chlorobenzene. A hazard index is the ratio of expected intake to the acceptable level of intake. A hazard index value greater than unity (i.e., 1.0) indicates the possibility of a health hazard to the exposed population. As the value exceeds unity, there exists an increasing risk of adverse response. A value of 190 is indicative of a clear health hazard. The concentration of chlorobenzene in groundwater at the property boundary also greatly exceeds the one-day health advisory of 1800 ug/L established by EPA for a 10-kg infant who may consume one liter of formula reconstituted with tap water (U.S. EPA, 1987b).

EPA's ambient water quality criteria for monochlorobenzene (U.S. EPA, 1980) established a water limit of 20 ug/L based on organoleptic data. The World Health Organization drinking water quality guideline for monochlorobenzene is 0.3 ug/L, which is not based on health considerations, but rather on the odor threshold (range 0.1 to 3 ug/L). The odor of chlorobenzene is medicinal (amine-like), and is pronounced and unpleasant at high-ppb levels. A concentration of 200,000 ug/L would be extremely objectionable and probably could not be tolerated.

It is also important to note that currently monochlorobenzene is not

classified as to its carcinogenicity. A National Toxicology Program bioassay (NTP, 1983) indicated that monochlorobenzene administration increased the occurrence of neoplastic nodules of the liver in male rats or mice of either sex. On the basis of these preliminary data, the National Academy of Sciences (NAS) derived an upper-bound estimate of risk of daily exposure to chlorobenzene in drinking water. The estimate of lifetime cancer risk of ingesting water containing 200,000 µg/L, based on the NTP data, is 2.13×10^{-2} (i.e., 4 cases of cancer out of every 100 people so exposed). The regulatory status of monochlorobenzene is currently under review by EPA.

Quantitative or qualitative estimations of risk due to contamination of groundwater as a result of the major spill of DCB and TCB, or to possible contamination of the confined aquifer by monochlorobenzene is not feasible at this time. In addition, the regulatory status and weight of evidence for categorizing monochlorobenzene and p-dichlorobenzene are currently under review (categorizations for weight of evidence have been pulled from EPA's IRIS, pending reassessment). At the present time, the health-based criteria of relevance for MCB, pDCB and TCB in drinking water are as follows:

	MCL (mg/L)	Concentration in drinking water corresponding to a 10^{-6} cancer risk (mg/L)	Proposed MCLG (mg/L)	Drinking Water Equivalent to Verified Risk Reference Dose (mg/L)
p-Dichlorobenzene	0.075	0.0015		
Monochlorobenzene	none	0.0024	0.06	
1.2.4-Trichlorobenzene	none	not classified as carcinogen	none	0.700

5.2 Human Exposure due to Ingestion of Fish

Red Lion Creek is recreationally fished. Notwithstanding an alert issued by the Delaware Department of Public Health in April, 1986, an exposure assessment and attendant risk analysis of pDCB and other chlorinated benzenes can be estimated by applying experimentally determined bioconcentration factors to measured water concentrations, or from tissue analysis data obtained by DNREC and EPA Annapolis Laboratory (see Table 2-5 of the Weston report).

Utilizing EPA's default value of 6.5 g/day for fish consumption, and assuming an average fish tissue concentration of 4 mg/kg (obtained from averaging the values measured in carp and white perch from Red Lion Creek), an average daily intake of 0.026 mg of pDCB is estimated. Conservatively assuming that this level of contamination and fish consumption continues over a lifetime, an added upper-bound cancer risk of about 9×10^{-6} is obtained (i.e., less than 1 case of cancer for every 100,000 individuals so exposed).

Alternately, assuming an average water concentration of 0.36 mg/L for pDCB (based on available data from the most recent sampling performed by Weston), and a bioconcentration factor of 370 L/kg, an average whole-body tissue concentration of 134 mg/kg is calculated. Consumption of 6.5 g/day of fish containing this concentration of pDCB could increase the lifetime risk of cancer by about 3 in 10,000.

These estimates of cancer risk provide a rough index of the potential risks to consumers of locally caught fish. A more refined estimate may be obtained by analyzing edible portions of tissues of fish which currently inhabit Red Lion Creek, and obtaining more accurate information concerning the upper limit of the amount of fish from this area that might actually be consumed.

Another consideration which relates to release of DCB and TCB into fish-

inhabited surface waters is tainting. For example, exposure of hens for 3 days to air containing 3.4 to 6.4 ppm of pDCB (used as a room deodorizer) imparted an unpleasant, sweetish taste to the egg yolks. Ill effects in the hens were not noted and there was no reduction in egg production (Patty's, 1981). Pork meat has reportedly been tainted with a disagreeable odor and taste as a result of the use of pDCB in pig stalls as an odor-control agent (HSDB, 1988). Very small amounts of pDCB can impart medicinal taste and odors. The threshold concentrations for odor and taste for pDCB in water were reported as 0.002 and 0.006 mg/L, respectively (Patty's, 1981). Trichlorobenzenes can likewise cause tainting of fish. Accordingly, pDCB and TCB even at levels that do not cause harm to aquatic life or its users may render a local resource as unusable.

5.3 Direct Contact

Exposure to contaminated surface soils and wetland sediments by fishermen, hunters, adventurous children is difficult to predict. If a small area of concentrated pDCB/TCB were left intact after the initial cleanup, a potential could exist for contact on clothing which could, after several hours of wear, result in severe irritation. DCB and TCB can be dermally absorbed. In addition, soil contaminated with DCB/TCB can be ingested by the inadvertent transfer from dirty fingers to food or the mouth. Assuming a fisherman frequents an area of surface contamination 25 days per year, and on each visit incidentally ingests 10 mg of soil/sediment containing on average about 400 mg pDCB (this value was obtained from the average of the March, 1988 sediment results provided in the Weston report), the average daily intake of pDCB is estimated to be 0.00027 mg. The added lifetime cancer risk due to this exposure is about 1×10^{-8} (i.e., less than 1 in 100 million).

It should be noted that concentrations of pDCB in the top two centimeters of sediment may be considerably higher than indicated by the samples (6 to 10 inches in depth) taken by Weston.

5.4 Inhalation Exposure

Inhalation of dusts containing pDCB/TCB is not expected to pose a significant exposure pathway. However, DCB is rather volatile and readily sublimes from its solid state. Health problems have been associated with the indoor inhalation of DCBs as a result of the liberal use of mothproofing and air-deodorizing agents containing DCBs as principle components. Evaporation and air dispersion models are available to predict release rates and concentrations at downwind receptor points. However, air monitoring is a much more precise and cost-effective method of determining exposure potential.

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Galina
I have asked Pat Davis for the missing attachment. She will FAX it. I assume Diane will handle. Joe

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF AIR AND WASTE MANAGEMENT

M E M O R A N D U M

TO: ~~Joseph Hardman~~
J. Paul Jones

FROM: Gary A. Molchan

SUBJECT: Standard Chlorine Permit Coordination

DATE: May 1, 1989

The Division of Water Resources is reviewing the NPDES permit for Standard Chlorine of Delaware, Inc. You will note in the attached memorandum that there is a focus on the organic chemicals derived from the processed waste waters and ground water recovery system.

Please have your respective staff work directly with Mr. Lee in providing the necessary information to adequately address their concerns in the development of the NPDES permit. Please keep a record of the time spent in your daily time sheets so that we may track the issuance of these permits. Please advise me of the effect of scheduling public notices and hearings and any overlap in our programs and the water programs in the future.

GAM:pd
GAM89047

Attachment